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PLATE XIX

URANIA

From "Statues Ancient and Modern," published in Rome in 1704.

This statue at one time belonged to the Queen of Sweden; in 1704, to Odescalchi, of Rome; now in Madrid.

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AN ASTRONOMER'S APOSTROPHE TO URANIA

Celestial Urania,
  Thy wonders we would know—
Those mysteries and marvels which
  Alone inspire us so
That nightly from this Earthly sphere
  We try to comprehend
Thy Universe as infinite,
  And ages without end.

O beautiful Urania,
  As thus we look afar,
And sight across the awful gulf
  Between us and that star
Which we have found of all thy host
  The nearest one to be,
How can we then but stand appalled
  By thy profundity?

O heavenly Urania,
  In numberless array
Thy suns and systems scintillate
  Throughout the vast display,
The clusters and the nebulæ,
  The Galaxy and all,
But midst this cosmic throng appears
  Our world, remote and small!

An Astronomer's Apostrophe to Urania

Celestial Urania,
  With thee can nought compare,
Thy magnitudes transcending thought,
  Thy view sublimely fair;
O heavenly Urania,
  Be ever this our aim:
To love, serve, honor, study thee—
  Thy Science to proclaim.

FREDERICK CHARLES LEONARD.

BERMUDA AND ITS ASTRONOMICAL NEEDS

By E. D. Robinson

BERMUDA is a coral archipelago in the Atlantic Ocean, in Latitude 32° 20′ N., Longitude 64° 47′ W., and more than seven hundred miles from its nearest neighbour, the United States of America. Bermuda is a self-governing colony and is, perhaps, the most northerly point on the globe where the living zoöphite still piles up its submarine architecture. It has many requirements, more especially astronomical equipment.

There was absolutely nothing of that sort here until the arrival of the Rev. Dr. D. B. Marsh, some three years ago. Prior to the date of his arrival the time was obtained from ships, or from various other sources. This often caused a variation of time, from five to ten minutes in the course of a very short period. Shortly after the arrival of Dr. Marsh, with the assistance of the writer, an astronomical transit was placed on the meridian and it is now the authority for time throughout the colony.

We met with cons derable difficulty in getting a suitable location for the transit, but finally solved the problem by placing it upon one of the walls of a stone house. From this position a meridian bench mark was well located at a distance of one mile. Bermuda uses local mean time and the difference between the 75th meridian time and the position of the transit referred to, is 40m. 40s. Our next move was to mount an equatorial telescope. The islands being of coral formation, which makes them unstable, we met with the same difficulty as we did with the transit. To overcome this difficulty a cement bed was prepared at considerable expense. The writer is quite conversant with these difficulties, having assisted in overcoming them.

Some years ago a Milne seismograph was purchased by the government and unfortunately was badly placed on Ager's Island. This is a very small island, not more than 800 yards in length and 150 yards wide. This instrument was used only a short time

and was considerably exposed to the sea. During the war with Germany, it was completely neglected and almost destroyed. Dr. Marsh discovered this seismograph and, knowing the need of it, made every effort to procure it, with the object of re-constructing it. The authorities granted his request and the instrument was sent to him, virtually in fragments. After months of hard labour the instrument was re-assembled and placed in a small stone building at the rear of his house where it is now in operation.

Some years ago, Sir Frederic Stupart, the Director of the Dominion Meteorological Service, Toronto, sufficiently interested the military authorities to have them receive and operate meteorological instruments in Bermuda. These are now situated on Prospect Hill, the equipment consisting of: barometers, thermometers and an anemometer. These instruments, for some time were carefully kept by Sergeant Mills, who was recently transferred to army work in England. The work is now carried on by Colonel Haughton and his observers.

Recently a radio-phone was established upon the island by Mr. Edward York, a member of the Royal Astronomical Society of Canada, by which comparison with Washington, for time, is occasionally made.

The writer has a three-inch Brashear telescope, mounted upon a tripod. It is equipped with the usual battery of eye pieces, with solar and stellar prisms and with a camera giving a field sufficiently large for lantern slides. He has recently been admitted to the American Association of Variable Star Observers and placed on the Committee to study variable Stars and report to the Harvard College Observatory from which monthly report blanks are supplied. These reports are published in *Popular Astronomy*, Northfield, Minn.

There is another three-inch telescope (Dolland) on the island, belonging to the Public Library, which was put in order by Dr. Marsh. This instrument is used by Mr. York, Mr. McLaughlin and others.

Owing to the smallness of our island and thus our proximity to the sea, there is considerable refraction in observing until the objects are well up in the sky. The heavenly bodies having reached

such observing point, both Dr. Marsh and the writer get some splendid views. Dr. Marsh is faithfully pursuing the study of the sun, the planets and seismic disturbances, using, for the sun and planets, the various necessary camera equipment.

What we are hoping to do, is to interest the government to the extent of building a small observatory in the city of Hamilton, the capital of the islands, capable of having a small telescope with a good time clock, transit instrument, seismograph, thermometers, barometers, anemometer and other instruments that may be necessary for proper equipment.

With only three telescopes suitable for observation on the island and they in the hands of private owners, and Bermuda being of such great importance, especially to ships going south and wanting to correct chronometers, and also as a military station and tourist resort, I am sure it cannot afford to be without the foregoing equipment.

Hamilton, Bermuda.

THE COMPUTATION OF PLANETARY CONFIGURATIONS

By W. T. B. Crombie

PLANETARY configurations, in the Ephemeris are classed under the general head of "Phenomena". Their computation is usually left until the ephemerides of the sun, moon, and planets have been prepared, when an inspection and simple interpolation of the respective co-ordinates concerned, will furnish the times of their occurrence. These are given to the nearest hour, except in the case of conjunctions with the moon, which are calculated to the nearest minute. The object of the writer of this article, however, is somewhat different.

He has felt that some encouragement should be given to those who, while interested in astronomy, never venture into the interesting and even fascinating field of astronomical prediction, labouring under the impression that much mathematical knowledge is required for such.

This is undoubtedly true in a large number of cases, but there are some computations which require very little, especially if we are content with a moderate degree of accuracy. We propose the computation of planetary configurations because to the ordinary observer these are always interesting and because their calculation is not difficult. Our "method" asks for nothing but arithmetic, with the exception of one or two references to a table of tangents. Of course if the reader is prepared to employ logarithms he should do so as the labour is very much reduced thereby, but these are not essential and have been omitted.

Briefly our method is as follows. The *approximate date* of conjunction or opposition is found by applying the synodic period to the date of last occurrence. The synodic period is merely the interval between two similar configurations. It is furnished in Table I, both in days and years, the former being used for times not far distant, (in which case only a few periods are involved) and the latter when a considerable number are to be added to the date of last occurrence. The reader should understand how

this period is obtained. Let the question be this: One runner has passed another on a circular track, at what moment will he pass him again? Clearly we must know the time each takes to make the whole circuit and form a multiple of these times and divide by the difference between them. Hence we have the familiar formula, Synodic Period $= pP/(p-P)$ for a superior planet, and $pP/(P-p)$ for an inferior one, P being the earth's *sidereal period* (see HANDBOOK) and p, that of the planet. It must be understood that this formula is true only in the case of *circular* orbits and hence, strictly speaking, not applicable to the planets at all. But if the eccentricity is small (as in the case of Venus) the synodic period will furnish the times of conjunction very nearly, especially if the planet should then be at or near its mean distance from the sun. Thus, if to the date of last occurrence of an inferior conjunction of Venus with the sun we add 583 d. 22 hrs. (see Table I), we get 1924, June 30, 16 hrs. A strict calculation not employing this period gives 1924, July 1, 1 hr.[1] Here there is a difference of only 9 hrs. But in most of cases the difference is much greater than this. Consequently we take the date furnished by the addition of the synodic period as only approximative and proceed to test it and, if necessary, correct it. To do this we calculate as nearly as we can the longitude of the planet (as seen from the sun) and that of the earth, likewise seen, for this approximate time. These are furnished by the mean longitudes (Table II) corrected by their respective elliptic equations. The mean longitudes are their angular distances from a fixed point (the first point of Aries) supposing circular orbits and equal *angles* in equal times, and the elliptic equations (equations of the centre) are the corrections to be applied to the circular motions to obtain motions in the corresponding ellipses. Having thus corrected the mean places, and obtained more nearly the true places of both planet and earth, we compare them. As viewed from the sun, at both opposition and inferior conjunction, earth and planet have the *same* longitude.[2] Hence, if the approximate date furnished by the synodic

[1]The time here and elsewhere in this article is G.M.T. and is astronomically reckoned, *i.e.*, from noon, not midnight.

[2]At superior conjunction they are 180° apart.

period is very nearly the *true* date, these two longitudes of planet and earth should be the same or differ only by a few minutes of arc. If, however (and this is more likely), they differ by a considerable angle, we find the difference, and divide it by the difference in the daily motions (Table II) of planet and earth, that is by the arc which one planet gains upon the other in a day, selecting the mean, the greatest, or the least according as the corrected positions would indicate when compared with the places of the perihelion as furnished by Table II. All this may seem much involved but the example which follows will enable the reader, we hope, not only to comprehend the method but to perform similar computations for himself. But before proceeding to this we must first show how the equations of the centre can be very nearly obtained, for we require these to correct the mean places.

The calculation of equations of the centre was, as the reader well knows, Kepler's problem. The task was not an easy one then, and indeed has grown little easier since, although the problem has long been solved. The truth is that there is no formula of any *simple* sort that will reduce circular motions to elliptic motions or equal angles to equal areas, in equal times, which is the true planetary law. To do so accurately we must employ equations of condition and these we are supposing to be beyond the limits of this paper. It is also presumed that the reader is without planetary tables, therefore we must hit upon some approximate rule which will furnish him these corrections as nearly as possible.

We fall back upon the old elliptic hypothesis attributed to Seth Ward though he himself said the credit for it was really due to Bullialdus. It was the last and best attempt to furnish a *simple formula* for finding the equation of the centre. It was examined by Kepler and rejected as wanting in accuracy. Still, in the case of the earth the error is never more than 17″, and even in the case of Mars, whose orbit is much more eccentric, the error may be no more than 7′; and as these quantities are very much less than the daily motions of these planets it will be sufficient for our purpose and will furnish the reader with the much

desired simple formula and will render this article complete in itself. Ward's formula was:

Aphelion dist. : Perihelion dist. : : Tan ½ mean anomaly : Tan ½ true anomaly.

By the *mean* anomaly is meant the angular distance of a planet from its perihelion supposing equal angles in equal times or circular motion. This anomaly is always obtained by subtracting the perihelion place from the mean longitude (see Table II and example below). On the other hand the *true* anomaly is measured from the same point but in the corresponding ellipse. The difference between these two is called the *equation of the centre* and the equations of the centre, added to or subtracted from the mean longitudes already obtained (see example) will furnish the *true* heliocentric places of the planet and earth at the time; that is, of course, leaving out of the account the error of the hypothesis itself and taking no account at all of perturbations occasioned by the other planets which, for the accuracy stated at the beginning, have little effect. The aphelion and perihelion distances required by the formula are found in Table III. Mean distance being the unit.

EXAMPLE (MARS)

Find the date of the next ☌ ☍ ☉.

Date of last opposition, 1922, June 10, 2 hrs.+779d. 22h. =1924, July 29, 0 hr. =approximate date of opposition. July 29, 1924, is the 576th day from January 0, 1923, the epoch for which Table II is calculated. Hence we have:

	For Mars			
Mean Long. at Epoch =	15°	56′	43″	(Table II).
+(576×31′ 26″)	301	45	36	" "
	317	42	19	= *Mean long.* ♂, *July* 29, 1924
−Long. of Perihelion (360° added)	334	38	30	(Table II).
	2)343	3	49	= *Mean anomaly*
	171	31	54.5	= ½ Mean anomaly.

By the Elliptic Hypothesis and Table III we have 1.0933 : .9067 : : tan 171° 31′ 54.5″ : tan ½ true anomaly.

Hence $\tan \frac{1}{2}$ true anomaly $= \frac{.9067 \times (-.148883)}{1.0933}$

½ true anomaly = 172° 57′ 40″
true anomaly = 345 55 20
−mean anomaly 343 3 49 (as above)

2° 51′ 31″ = *Equation of Centre.*

This must be *subtracted* from the mean long. since Mars has not yet reached his perihelion the equation of the centre being negative from aphelion to perihelion and positive from perihelion to aphelion.

Thus we have 317° 42′ 19″
− 2 51 31

314° 50′ 48″ = *Corrected place of* ♂ *for July* 29, 1924.

For Earth

Mean long. at epoch	= 99°	8′	4″	(Table II).
+(576×59′ 8″)	207	40	48	(Table II).
(360° subtracted)	306	48	52	= mean long. ⊕ July 29, 1924
−Long. of perihelion	101	36	58	(Table II)
	2)205	11	54	= *Mean anomaly*
	102°	35′	57″	= ½ Mean anomaly.

By the elliptic hypothesis and Table III, we have 1.0167 : .9833 : : tan 102° 35′ 57″ : tan ½ true anomaly.

Hence tan ½ true anomaly $= \frac{.9833 \times (-4.47405)}{1.0167}$

½ true anomaly	=103°	0′	45″
True anomaly	=206	1	30
−Mean anomaly	205	11	54 (as above)
	0°	49′	36″ = *Equation of centre.*

By comparing the mean long. with the place of the perihelion it is seen that ⊕ has passed her aphelion (180°+perihelion). Hence as before the equation of the centre is negative and we have

306° 48′ 52″
− 0 49 36

305° 59′ 16″ = *Corrected place of* ⊕ *for July* 29, 1924.

By comparing now the two corrected places it is seen that ♂ is in advance of ⊕ by 8° 51′ 32″ but as ⊕ has nearly double the speed of ♂ (Table II) she will soon come up to him and be in a line with him as seen from the ⊙ or ♂ be in opposition as seen from ⊕. The question is, what time is required to accomplish this. That will depend on their relative daily motions at the time and these latter upon their respective positions in their orbits, for the nearer they are to their perihelions the faster they move. Now observe (Table II) that on July 29, 1924, ♂ has almost but not quite reached his *perihelion*. Hence his speed is nearly, though not quite, as great as possible. His greatest speed is about 38′ 6″ per day. But he is about 20° from perihelion which for him is 334° 38′ 30″. Observe also that ⊕ has passed by about 24° her *aphelion* which for her is 281°

31′ 58″ (180°+perihelion). Hence her speed is increasing. Her smallest speed is 57′ 11″ per day. Table II furnishes the difference between speed at mean distance and speed at perihelion and aphelion distances and we have only to remember that the mean distance points are each *approximately* 90° from either perihelion or aphelion points. Hence we have the following simple proportions:

For Mars—90° : 6′ 40″ : : 20° : 1′ 29″, which is the amount he is short of his perihelion speed, *i.e.*, his motion per day is 38′ 6″−1′ 29″ or 36′ 37″. And

For Earth—90° : 1′ 57″ : : 24° : 31″, which is the amount she has gained upon her aphelion speed, *i.e.*, her motion per day is 57′ 11″+31″=57′ 42″. Consequently the earth *gains* upon Mars *in one day* 57′ 42″−36′ 37″ or 21′ 5″.

Now the difference of long. between them on 1924, July 29, 0h, was 8° 51′ 32″, which divided by 21′ 5″ gives 25.21 dys. Consequently the true date of the next ☍ ♂ ☉ is 1924, July 29, 0h+25d 5h or 1924, *August* 23, 5*h*, which is precisely what a rigid computation based upon proper planetary tables gives.

In conclusion it may be pointed out that the synodic period may be used to find also the approximate times of greatest elongation of ☿ and ♀, as also the stationary points of both inferior and superior planets. Care must however be taken that it is the same elongation (E. or W.) that we have in mind. The same is true of the stationary points. We must reckon from stationary point before ☍ to the same point again or from stationary point before inferior ☌ to the same. The difficulty however is to form a simple scheme for testing and correcting the dates thus obtained, for we must remember that in these cases we are deprived of the advantage stated above, namely that at inferior ☌ or ☍ the heliocentric positions are the same for both planet and earth and in superior ☌ they differ by exactly 180°.

The writer is endeavouring to form such a scheme and one for the calculation of conjunctions of planet with planet. These latter are much more difficult. Take for example conjunctions of ♀ and ♂. In some years we have *one*. These are alternated by years when they are *none*, and occasionally we have *three* in one year. The latter happens in this way. ♀ can approach ♂ only when the latter is drawing near the ☉. If at that time the beautiful goddess is going out to her bower (stationary point) she may overtake the warlike friend as she goes, and deliberately overtake him as she returns (moving retrograde) and once more face about and catch up to him again. Such a little flirtation happened in 1921. Who can form a *simple* scheme for the prediction of such things as these!

Kingsbury, Que.

[Tables on next pages.]

TABLE I

Planetary Configuration	Date of Last Occurrence G.M.T.	Synodical Period in Days	Synodical Period in Tropical Years
Inf. ☌ ☿ ☉	1923, Jan. 28, 16 hr.	115 dys. 21 hrs.	.31726
Inf. ☌ ♀ ☉	1922, Nov. 24, 18 "	583 " 22 "	1.59872
☍ ♂ ☉	1922, June 10, 2 "	779 " 22 "	2.13539
☍ ♃ ☉	1922, April 4, 1 "	398 " 21 "	1.09211
☍ ♄ ☉	1922, Mar. 25, 5 "	378 " 2 "	1.03518
☍ ♅ ☉	1922, Sept. 4, 11 "	369 " 16 "	1.01209
☍ ♆ ☉	1922, Feb. 3, 16 "	367 " 12 "	1.00614

TABLE II

Epoch of this Table: January 0* d. 1923 G.M.N.

Planet	Mean Longitude at the Epoch	Longitude of Perihelion	Daily Motion at Perihelion Distance	† Difference for 90°	Daily Motion at Mean Distance	† Difference for 90°	Daily Motion at Aphelion Distance
	° ′ ″	° ′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
☿	354 8 46	76 15 27	379 17	133 45	245 32	80 53	164 39
♀	120 59 3	130 29 15	97 30	1 22	96 8	1 15	94 53
⊕	99 8 4	101 36 58	61 10	2 2	59 8	1 57	57 11
♂	15 56 43	334 38 30	38 6	6 40	31 26	5 14	26 12
♃	216 20 13	13 4 55	5 30	31	4 59	27	4 32
♄	187 56 50	91 32 21	2 15	15	2 0	12	1 48
♅	342 13 53	169 25 1	46	4	42	4	38
♆	135 35 22	43 57 24	21.3	.3	21	.4	20.6

*By January 0 is meant December 31, 1922, Mean noon, which for convenience of reckoning is called the beginning of the astronomical year and avoids confusion in years which are bissextiles.

†The differences between adjacent columns.

TABLE III

	Aphelion Distance	Perihelion Distance	
☿	1.2056	.7944	
♀	1.0068	.9932	
⊕	1.0167	.9833	
♂	1.0933	.9067	Mean Distance in all cases = 1.
⚳	1.0483	.9517	
♄	1.0558	.9442	
♅	1.0471	.9529	
♆	1.0085	.9915	

NOTE; RELATIVE TO CHANGES IN A SPECTRUM-TUBE OF HELIUM

By A. F. Miller

NOT long after the recognition of Helium as a terrestrial element I procured from a reliable British dealer a spectrum-tube of that gas. It gave the six characteristic visual bright lines of Helium with perfect clearness, also a faint Hydrogen spectrum. I used the tube quite frequently during two or three ensuing years, but then noticed that the Helium spectrum was gradually becoming fainter, while a quite different spectrum like that of CO_2 (or some other gaseous compound of Carbon), began to develop, substituting itself for the spectrum originally given by the tube. While regretting this occurrence it did not surprise me, changes of that nature happening only too frequently with spectrum-tubes, particularly with commercial ones.[1] I continued to use the tube (no longer a Helium tube), at intervals when requiring a spectrum of CO_2. In its original condition when transmitting the electric discharge the colour of the constricted part had been brilliant yellow, with faint bluish striae in the expanded portions: but after the change had occurred the whole tube shone with a fine green illumination, its spectrum being the series of bright bands "sharp toward the red" characteristic of the gaseous Carbon compounds, the Alpha (6563) and Beta (4861) lines of Hydrogen also being visible faintly.

Last winter when Professor McLennan was conducting those important original researches on Helium, with which you must all be familiar, he very kindly presented me with an excellent spectrum-tube of pure Helium. I was naturally much pleased to have this accessory, and while studying its spectrum it occurred to me to compare this latter with the spectrum of my original Helium tube (then metamorphosed into CO_2). Accordingly I arranged the tubes side by side, both being simultaneously illumi-

[1]Salet: *Analyse Spectrale*, 207.

nated by the discharge from the same coil, and observed the spectra by the usual comparison method. At first there was not the least resemblance between the two spectra seen in that way; but after I had repeated the experiment several times I noticed an increased brightness in the yellow region of the spectrum yielded by "tube 1" (as I will hereafter term it, while that given me by Dr. McLennan I will call "tube 2"). Continuing to observe tube 1, I noticed that a fine bright line had appeared in the yellow. Thinking this line might be due to Sodium vapor evolved from the glass by a too intense spark, I changed the coil for one giving a discharge of much less intensity. However the yellow line continued to increase in brightness, and comparison with the familiar Sodium pair showed it was single and slightly more refrangible than these. It therefore became evident that He_a had reappeared (a thing I never expected). And as I continued working tube 1, still using the smaller coil, sometimes in parallel with tube 2, but more frequently alone, I saw with surprise a gradual but complete reappearance of the Helium spectrum, while that of the Carbon gas gradually faded to entire extinction. Under this changed condition tube 1 gave a precisely similar spectrum to tube 2, except that in the former two Hydrogen lines were faintly visible, while these were scarcely perceptible in tube 2.

I laid aside the Helium tubes for a couple of months while engaged in another investigation, but later having occasion to make use of tube 1, I found with a certain degree of surprise that the CO_2 spectrum had reasserted itself, the He spectrum having disappeared except that the yellow line was still faintly visible. Thereupon I again arranged tubes 1 and 2 in connection with one another and with the coil as at first, and after operating them in this way for about twenty minutes I saw that the yellow Helium line had become much more brilliant while traces of the other Helium lines began to show out. After another twenty minutes the CO_2 spectrum had entirely vanished, while all the characteristic Helium lines were once again strongly in evidence. I could not then doubt that these curious and unexpected effects were due to the action of tube 2 upon tube 1.

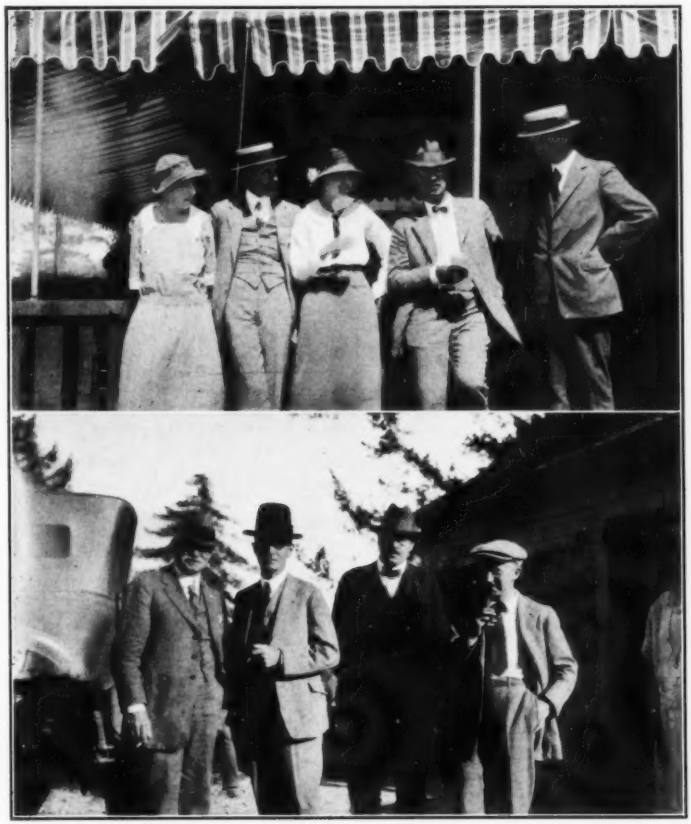
I am of opinion that the phenomena I have described are effects of *resonance*, the powerful vibrations of the pure Helium

in tube 2 imparting their own periodicity to the responsive gas in tube 1. The Helium in the latter in that way became ionized and conducted the whole current, while the CO_2 having a different vibration period remained quiescent. The double recurrence of the phenomena leaves no doubt as to their having resulted from the action of tube 2 upon tube 1, whatever be the explanation offered. I may remind you that Ångstrom was led by the theory of Resonance to give the first true explanation of the cause of the Fraunhofer lines, which he stated several years prior to Kirchhoff's sodium-flame experiment.

I will just add that I have investigated the effect of coupling tube 2 with tubes of CO_2 containing no Helium; these naturally underwent no change.

Toronto, Can.

PLATE XX



At the Meeting of the American Astronomical Society.

Above, from left to right: Mrs. Mitchell, S. A. Mitchell, Mrs. Adams, J. Stebbins, W. S. Adams.

Below: C. E. St. John, F. H. Seares, F. G. Pease, A. van Maanen.

Journal of the Royal Astronomical Society of Canada, 1923.

PLATE XXI

Upper: Camp Wrigley, near Avalon, Catalina I.

Lower: Canadians at Camp Wrigley, from left to right: J. S. Plaskett, H. R. Kingston, Elizabeth R. Laird, N. B. McLean, Annie L. Laird, J. W. Campbell. Sitting in front: Mrs. Kingston, Mrs. Plaskett.

Journal of the Royal Astronomical Society of Canada, 1923.

A GREAT ASTRONOMICAL MEETING

By J. S. Plaskett

THE month of September, 1923, was an important one for astronomy in Western America, as it contained two unusual astronomical events, both happening in the State of California. A total eclipse of the sun occurred on September 10th, and a combined meeting of the American Astronomical Society, of the Astronomical Society of the Pacific and of Section D of the American Association was held at the Mt. Wilson Observatory on September 17-19. Although the sky was unfortunately more or less completely clouded at most of the observing stations on September 10th, the meeting was very successful and many important astronomical results were there announced. It is proposed in this article to say something about the eclipse and to give a short account, in as non-technical language as possible, of the principal advances in astronomy described at the meeting.

The eclipse of September 10, 1923, in which the shadow path passed over the south-western corner of the State of California and thence through Mexico was more favourable than any occurring in America for many years to come and very elaborate and complete preparations were made for observing it. The Yerkes, Washburn, Des Moines and Northfield Observatories had instruments and parties near Avalon, Catalina Island; Pomona College planned to observe the eclipse about ten miles south on the same island. The Mt. Wilson Observatory had installed a very complete equipment at Point Loma, near San Diego, and many new experiments and observations were proposed to be tried there and at the observatory on Mt. Wilson, where the eclipse would be about 99 per cent. total. At Point Loma was situated also the apparatus of the McCormick Observatory and several other observers were also located in the neighbourhood. The Lick Observatory expedition, usually very successful in choice of sites, with some other parties were located at Ensenada in Mexico, a few miles south of the border and a short distance inland.

The chances of clear skies at all these stations, as estimated from observations over several previous years, were very favourable, about 90 per cent., and no one expected in sunny California anything but favourable weather. But at the time of totality, the skies were almost completely cloudly all along the coast and no successful observations were made either on Catalina Island, near San Diego, or at Ensenada. Only in the interior of Mexico, where the conditions were not considered so favourable, were any photographs obtained and the Sproul and Steward observatories and the German expedition obtained some valuable results.

It was very unfortunate that the weather was cloudy, as preparations had been made for many new and important observations of the corona, the flash spectrum and the displacement of the light rays, and it will be many years before such a favourable opportunity again occurs. The time occupied and the expense involved in preparing for the observations was very considerable, and it was very disappointing and disheartening to the astronomers to have everything ready, all the apparatus adjusted and the programme carefully rehearsed for the three minutes or so of totality, and then to start and dismantle the equipment after the moon had passed over the solar disc behind such thick clouds that no results could be obtained. The writer had made no particular preparations for observing, but had gone to Catalina to see the eclipse and his principal feeling was one of deep sympathy for those who had given so much time in preparation without any return and of regret for the loss to science of the proposed experiments and observations.

However, everyone took the disappointment philosophically and as soon as their apparatus was dismantled and packed up, hastened to Pasadena to make up for their disappointment by taking full advantage of the opportunity the location of the shadow path offered of viewing the equipment and discussing the work of the Mt. Wilson Observatory. As the astronomical meeting did not begin for a week later than the eclipse, this gave a fine chance to see more of the work of the observatory than if the eclipse had been successful and every one occupied with developing plates and discussing results. This formed a partial compensation for the failure and was fully taken advantage of by the writer and many of the visiting astronomers.

The work of the Mt. Wilson Observatory is so varied and its equipment so complete and original as to make it a most valuable experience for astronomers.

The astronomical meetings began on Monday, September 17, at the University of Southern California, in Los Angeles. The Monday morning session, presided over by President W. W. Campbell, of the University of California, President of the American Astronomical Society, consisted principally of papers on meridian astronomy and celestial mechanics, which, though important in the progress of astronomy, hardly lend themselves to description in a popular article. The afternoon session, although given by the Astronomical Society, was of such timely and general interest that it was open to all the sections of the Association and to the affiliated Societies, and consisted of a symposium on eclipses and relativity and a report of the eclipse expeditions. There were four addresses on eclipses and relativity, the first being by President Campbell on "Some Conditions Apparently Existing in the Solar Corona."

President Campbell is probably the most indefatigable eclipse observer in the world and has organized and attended ten expeditions, eight of which have been successful and only two cloudy. Consequently the Lick Observatory possesses the most complete and continuous series of photographs of the solar corona, all made with the same instrument under as nearly as possible similar conditions. Dr. Campbell traced the changes in the appearance and structure of the corona and correlated them with the sun spot period, illustrating this correlation by beautiful photographs of the corona. Nevertheless the constitution of the corona remains an unsolved problem and it is much to be regretted that the observations of the present eclipse, which might have added considerably to our knowledge of this mysterious phenomenon, were prevented by clouds.

The second address of the Symposium was given by Dr. R. J. Trumpler, Assistant Astronomer at the Lick Observatory, on "Relativity as Represented by the Einstein Eclipse Problem." Dr. Trumpler, who, under Dr. Campbell, had charge of the observations for the relativity bending of light at the Australian eclipse, gave an account of the observations and measurements made to determine the amount of its deflection. As is well known, the

Einstein theory predicted that the light from a star just grazing the edge of the sun would be bent inwards by a very small angle, 1.74 seconds of art, while, according to the Newtonian theory, the bending should be only half this amount, 0.87 seconds. The bending of the light from neighbouring stars will decrease proportionately with the distance from the centre of the sun. If, then, a photograph of a star field is made when the sun is in another part of the sky and again when the eclipsed sun is in the field, the star images in the latter case will be spread outwards, away from the sun, by the amounts given above. This quantity, on the average only about half a second of arc for the stars in the Australian eclipse field, corresponds to a very small displacement of the images on the plates, less than one two-thousandth of an inch, and it is obvious that great care and skill is necessary to measure and calcuclate this small displacement. Dr. Trumpler showed that the measures of Dr. Campbell and himself on the Australian plates agreed in giving a displacement of almost the exact amount predicted by Einstein and that there was no possibility that the displacement could be the half amount required by the Newtonian theory. As the plates obtained by Dr. Chant and Dr. Young at the same eclipse and measured by Dr. Young and Mr. Harper, although not of so good quality as the Lick plates, also gave a similar deflection and as the results obtained in the British expedition of 1919 were thus fully confirmed, there can be no doubt that, whatever the cause, the deflection of light caused by the gravitational pull of a heavy body like the sun is of the amount predicted by Einstein and should thus be rightly considered a confirmation of the general theory of relativity. The anti-relativists, while admitting that the deflection is present, claim that it may be due to another cause or causes, but it seems to me that the confirmation of Einstein's third prediction, announced by St. John at this meeting and described below, pretty well takes the ground from under their feet and that they are leading a forlorn hope.

The third paper of the Symposium was given by Dr. S. A. Mitchell, Director of the Leander McCormick Observatory, Virginia, and a Canadian by birth and education, on "How the Sun's Atmosphere is Studied at Eclipses and the Interpretation of the Results

Through the Aid of Modern Physics." One of the most thoroughly studied of the phenomena observable at the time of a total eclipse of the sun has been what is commonly called the Flash Spectrum, and Dr. Mitchell has probably done more work on the flash spectrum than any other astronomer. As is fairly generally known, the solar spectrum is an absorption spectrum consisting of a bright band of the rainbow colours crossed by a great number of fine dark lines. The spectrum is produced by the glowing photosphere, the luminous disc of the sun, which gives the coloured background, while the dark lines are due to the absorption of a surrounding atmosphere, which, though highly luminous and consisting of the incandescent vapours of the various elements present in the sun, is less luminous than the photosphere. The light from the photosphere is absorbed only in the positions in which the various elements present in the surrounding atmosphere, if vapourized in the laboratory, would give bright lines. This obviously forms a means of identifying the elements present in the sun, but it must be remembered that normally these lines can only be seen in the solar spectrum as dark lines. When, however, the bright photosphere is just covered by the disc of the moon at the time of eclipse, the surrounding atmosphere, also luminous, as above stated, has a chance to send its spectrum unaffected by the underlying photosphere, direct to the spectroscopes, and we then evidently get, not a dark line, but a bright line spectrum, the bright lines replacing the dark lines of the normal solar spectrum. This luminous atmosphere of the sun only extends to a height of about 800 miles, and is evidently progressively covered by the disc of the moon as it advances across the sun. Successive spectra taken during the interval enable the elements present at different heights in the solar atmosphere to be determined. Dr. Mitchell, from flash spectra obtained at different eclipses, has tabulated very completely and carefully the heights to which the various elements rise and in his paper analysed the bearing of these levels on Saha's ionization theory, which gives the only accepted explanation of the formation and constitution of stellar atmospheres. The importance of the work of Dr. Mitchell chiefly consists in its offering a hope, by its attack in detail upon the only star susceptible of such method, of explaining the nature of the great furnaces of the stars and the pro-

cesses which govern their evolution through the various stages we see exemplified in the sky.

The fourth paper of the Symposium, The Constitution of the Sun's Atmosphere, the Levels of the Gases and the Nature of their Circulation, by Dr. C. E. St. John, of the Mt. Wilson Observatory, contained, in my opinion, the most important pronouncement of the meeting. The third astronomical prediction of Einstein, based on the general relativity theory, states that the spectrum lines given by a heavy body such as the sun are displaced to the red by about a hundredth of an Angstrom unit, an amount the same as would be produced by a velocity of about two-thirds of a kilometre per second away from us. Various attempts have been made from time to time to verify or disprove this prediction, but with contradictory and uncertain results. Dr. St. John has been working on this enormously difficult and complex problem for some years and has only now been able to reach a definite conclusion. The problem is difficult because the displacement is very small and because other causes than the Einstein shift may readily produce it. Pressure in the solar atmosphere will cause shifts in the same direction, while a downward drift of the vapours on the region observed, at the speed of half a mile a second, relatively slow for the solar atmosphere, would produce the predicted displacement. Other causes such as anomalous refraction or scattering are quite capable of producing the required shifts and though it is easily possible to measure the predicted displacement, the difficulty of the problem consists in disentangling the various causes and determining to which of these causes any observed displacement is due. Dr. St. John, after most exhaustive analysis and careful examination of all the effects, has reached the conclusion that the displacement of the lines of the solar spectrum predicted by Einstein is certainly present. He finds, in addition, that the upper levels of the solar atmosphere are moving downwards with a velocity of about three-tenths of a kilometre gradually decreasing to zero at a middle level, while in the lower levels there are upward movements of about the same speed. These movements are additional to the Einstein displacement, which, as above stated, gives a shift of the lines equivalent to a downward speed of six-tenths of a kilometre. Although measurements have been made by other

physicists and astronomers, some confirming and some denying the relativity shift, everyone has been waiting for St. John's pronouncement on the question and will be willing to accept it as final, not only on account of his great skill and carefulness, but also because the instrumental facilities at Mt. Wilson are much superior to those of any other observatory or laboratory. That Dr. St. John has been one of the doubters as to the correctness of the relativity theory and has, as it were, been convinced against his will of the reality of the Einstein spectral line displacement, only makes his final conclusion more certain of general acceptance as the last word on the question.

While many astronomers and physicists have been unwilling to accept the general theory of relativity so long as the three astronomical predictions of Einstein were unconfirmed, this proof of the third prediction hardly leaves any stable basis of opposition, and, although the irreconcilables may still claim there may be some other explanation of the observed facts, the proof provided by the observation of two previously unsuspected phenomena theoretically predicted by the relativity theory and the explanation given by a previously unexplainable anomaly in the motion of Mercury, furnish such a high probability of the substantial correctness of the relativity hypothesis as should place the doubters very much in the minority.

While it is probable that the present enunciation of the principles of relativity is not the final one, it furnishes such a complete and satisfyingly logical explanation of the fundamental facts of nature as to at least make a good working hypothesis and though the present generation of physicists and astronomers may find difficulty in accepting and using this great generalization, this difficulty will disappear with time.

After the four addresses of the Symposium, reports of the results of eclipse expeditions were received. Apparently the only results of any great scientific value were obtained by the Swarthmore expedition which secured five photographs of the corona and also some plates for the relativity bending of light, which were reported on and shown by Prof. J. A. Miller. Prof. Douglas, of the Steward Observatory, also obtained some coronal photographs, and it was reported that the German expedition, Ludendorff and Kohlschutter, had been successful. The stations in the interior of Mexico, where

the meteorological conditions were supposed to be much less favourable than in lower California, obtained successful results while in sunny California, whose climatic reputation has been somewhat damaged by the failure, the sky was completely clouded along the whole path of totality. The programme for the day was completed by a splendid evening address by Prof. Lewis, of the University of California, giving a popular exposition of the principles of relativity and presenting the subject in an understandable and fascinating manner to a general audience.

The meetings of Tuesday were held in Pasadena, in the morning in the library of the Mt. Wilson Observatory laboratory, and in the afternoon in joint session with the American Physical Society in the Norman Bridge Physical Laboratory of the California Institute. Five papers on general astronomical subjects were given at the morning meeting, of which probably the most interesting and important, at least to the writer, was the paper by Dr. P. W. Merrill, of the Mt. Wilson Observatory, on the Radial Velocities of Long Period Variable Stars. This paper is the result of several years' observations of these stars and summarizes the velocity results for 135 stars. The average velocity is considerably higher than for the regular M-type stars and some correlation between velocity and period and between the velocities given by bright and dark lines were obtained. Dr. Merrill is continuing his investigation to obtain some physical relationships, and it is certain that our knowledge of these enigmatic objects will be much increased when his work is completed. Dr. Aitken gave a paper on the hypothetical parallaxes of 135 double stars and Dr. Luyten deduced some interesting conclusions in regard to our nearest neighbours in space. Dr. Townley gave details of a new catalogue of variable stars now in preparation, and Dr. Adams presented papers dealing with the motions and parallaxes of the Praesepe cluster and of the mean parallaxes of certain groups of stars.

After a dainty luncheon, provided by the Observatory, the members were driven to the Norman Bridge Laboratory, where the afternoon meeting, in joint session with the American Physical Society, was held. Papers on physics and astronomy alternated in this programme and those of general interest to both sciences only were

selected for this afternoon. The first paper was an interesting and valuable working hypothesis on the origin of the nebular lines, by H. H. Plaskett, presented by the writer. A previous hypothesis, that the lines were due to a hypothetical element nebulium of atomic weight about three, by J. W. Nicholson, met with difficulties, as there is no place in the periodic table for such an element, and the idea has been pretty well abandoned. The origin of the nebular lines and of a few lines in the spectrum of the corona is probably the most outstanding problem of astronomical physics and any hypothesis promising a satisfactory solution is a great advance. H. H. Plaskett has conceived the idea that the nebular lines are due not to the atom of some element, but to a molecule, the most probable being a combination of hydrogen and helium. Such a compound molecule, which would normally have a small moment of inertia, would give a banded spectrum, but the separation of the individual lines of the bands would be so great owing to the small moment of inertia that no bands or band heads would be recognizable and the nebular spectrum might well be of such a class. Probable band groupings for 17 out of the 34 known nebular lines have been obtained and the computed positions agree reasonably well with the observed. Further, these groupings agree with the conditions of excitation, strength and appearance in the nebulae and do not violate any known conditions. They provide for all the known strong lines in nebular spectra and furnish at least a good working hypothesis for the finding of this molecule and the production of the nebular lines in the laboratory. A star giving a unique spectrum containing not only the nebular lines in unusual relative strength, but emission lines of ionized iron and titanium has recently been discovered at Victoria, and it is hoped that additional astronomical evidence may be obtained in this very important question. While it will probably be a difficult laboratory problem to produce these lines, a consideration and following as far as possible of nebular conditions should not prove an insuperable task and the identification of almost the only remaining unknown lines in celestial spectra be an accomplished fact.

An interesting and valuable paper, by Nicholson and Pettit, of the Mt. Wilson Observatory, on the radiation from stars and

planets, as measured by a differential theromopile and photographically recording sensitive galvometer, showed promise of very important results soon being available. Father Rodés, of the Observatory del Ebro, Spain, presented a paper showing very distinctly the correlation between solar magnetic storms and terrestrial magnetic action. Dr. J. A. Anderson described a method for obtaining electrical discharges of high ionizing power by the discharge of a very large condenser through metallic terminals in a vacuum. A very large number of new spectral lines are shown in many of the metals, especially calcium and lead where there are hundreds of them. These new lines must be a product of super-excitation and the method promises developments of great importance. One of the most striking and startling of the results presented at this meeting was, however, a paper by Gustaf Stromberg, of the Mt. Wilson Observatory, on Asymmetry in the Distribution of Stellar Velocities. His conclusions result from a statistical investigation of the space velocities of a large number of celestial objects made possible by recent researches at Mt. Wilson and elsewhere, and indicates that there is a preferential direction in space along which celestial motions tend, which is in apparent contradiction to the theory of relativity according to which no absolute origin or direction can be chosen or found in space. The velocities of all celestial objects are directed almost wholly towards one hemisphere of the celestial sphere, but the physical meaning or cause of this preferential direction is not yet apparent.

We appear to be just on the verge of tremendous developments in science, and it would be rash to make any statements or attempt any prediction of the ultimate trend of these developments. It is, at any rate, obvious, even if the three predictions of Einstein have been fulfilled, that the end is not yet, and that it will be wise to maintain an open mind on the whole subject.

Perhaps the most interesting and profitable and certainly the most enjoyable of the meetings was held on Wednesday at the Mt. Wilson Observatory. Stages left the laboratory at Pasadena at 9 a.m. and arrived at the summit about 11 a.m., after a very enjoyable, and to those who had not previously experienced it, a rather thrilling drive. After walking around the Observatory grounds, riding in the bucket

to the top of the 150-foot tower, looking at the 60-inch and 100-inch telescopes and various other activities, an enjoyable and satisfying luncheon was served at the Monastery. The last and final session was held in the 100-inch dome, a most appropriate and unusual place for an astronomical meeting. All the papers presented at this meeting were very properly and suitably presented by members of the Observatory staff and included a paper by Dr. G. E. Hale, whose absence from the meeting at the observatory he had established, was deeply regretted. The meetings were closed by the usual votes of thanks, which, in the case of the thanks to the director and members of the staff of the observatory, was very specially and heartily responded to. Most of the members remained over night and had the unusual opportunity and privilege of seeing such objects as the moon, the Hercules Cluster, the Ring Nebula, a planetary nebula, etc, through the 60-inch and 100-inch telescopes under excellent seeing conditions, a fitting and pleasant climax to a banner meeting.

Although the first part of this astronomical expedition, the observation of the eclipse, was such a dismal failure, compensation was afforded the disappointed would-be observers by the great success, the enjoyable character and the importance of the results of the after-meeting. I am sure I am only expressing the sentiments of all fortunate enough to attend this memorable and most enjoyable meeting when I express my belief that it was one of the most successful meetings of the Society. Every member attending must feel deeply grateful to Dr. Adams, the director, to his charming wife, and to all the members of the staff, for their hospitality and for the complete surrender of their time and effort towards the entertainment and instruction of their guests. Their kindness was deeply appreciated, not only by the writer, but by everyone who attended, and the meeting will be long recalled as one of the most profitable and enjoyable of all the meetings of the Society.

Dominion Astrophysical Observatory,
Victoria, B.C.

A SIMPLE DESCRIPTION OF THE SYSTEM OF THE STAR BOSS 6148

By W. E. Harper

FOR some time past the writer has made no contributions to the Journal, as he has come to believe that the general reader is not at all interested in articles which are necessarily more or less technical in their make-up. True, there are those who are interested in the results of astronomical reasearch, but most of such persons have access to the publications of our Observatory, where the results are published in greater detail. Nevertheless in conversation with different members of the Victoria centre of the Royal Astronomical Society of Canada, I have been led to the conclusion that if technical expression were avoided and the subject matter was put in language sufficiently simple, such an article would be read and appreciated by a greater number of our members. As we have in the various centres of the Society throughout Canada a large body of lay members whose interest and goodwill are invaluable to the cause of astronomical research in our country, it is surely worth a little effort to try and put the results before them in a way that will at least ensure their being read. Consequently I am going to attempt in the present article to put in everyday language the results of a minor investigation of a certain star, upon which I have recently spent a little time. The professional astronomer or those who wish to know more of the specific details, can pass this by and consult our Publications. Volume II., No. 13, which is now in press.

The star is number 6148 in the catalogue of Boss and is too faint to be seen by the naked eye, except where the skies are exceptionally clear or the eyesight particularly keen. We speak of its visual magnitude—a term meaning not its size, but its brightness—as 5.7, and it is thus close to the magnitude of 6.0, which the first makers of star catalogues adopted as the limit of their vision. It is rather perplexing to the beginner in astronomy that the brighter the star, the

smaller is the number representing that brightness. Thus a star of magnitude 5.0 is approximately two and one-half times as bright as one of magnitude of 6.0, while one of magnitude 4.0 is two and one-half times as bright again as one of magnitude 5.0. Thus the pole star, with which everyone is familiar, whose magnitude is 2.1, is 3.6 magnitudes brighter or approximately 27 times as bright as our friend Boss 6148 under consideration.

If we could see this star with the unaided eye, it would be much like the pole star in its colour. Everyone has noticed how the stars differ in colour, shading from blue to yellow and red. This colour difference corresponds to different stages in the life history of a star and they have thus been graded into six great classes designated by six letters of the alphabet B, A, F, G, K and M. The B stars are the bluish stars, whose very hot atmospheres consist of the lighter gases helium and hydrogen, whilst at the other end of the scale, we have the reddish M stars clothed with cooler atmospheres containing the oxides of various metals. This star is about half way on the scale between F and G, and is thus not so far advanced in old age as our own sun whose type is G.

Readers of the JOURNAL have been made familiar with the method of analysing a star's light by passing it through a prism spectroscope attached to the large reflector. The function of the telescope is simply to increase the star's apparent brightness by gathering as much of its light as possible, so that when the light is spread out into a long band by the spectroscope, it will not require prolonged exposures to affect the sensitive plate placed in the proper position to receive it. Under average conditions, less than half an hour is sufficient to record this star's spectrum on the plate, though in good seeing much less time will suffice. Exposures much longer have been made, however, with a particular object in view. The spectrum consists of numerous lines or dark spaces interrupting the otherwise continuous band of light, red at one end and shading through the rainbow colours to violet at the other. These lines indicate the presence in the star's atmosphere of absorbing gases of iron and other metals and, among other things, it is their position in the spectrum, which gives us our information about the star. To get their positions, it is necessary to have some reference marks and the

spectrum of the iron arc is photographed side by side with that of the star. If the star is stationary, the two sets of iron lines, those of the star and those of the arc, will be exactly in line; if the star is moving towards us, its lines will all be displaced one way, whilst if it be receding from us, they will be shifted the opposite way. I shall not stop to state the reason for this; suffice it to say that by measuring under a microscope the amount of such shift of the lines at various dates, it is possible to tell the velocity of the star towards us or away from us upon such dates.

The star has been observed on 30 or more dates in the years 1919, 1920 and 1922, and the 30 plates thus secured when measured and

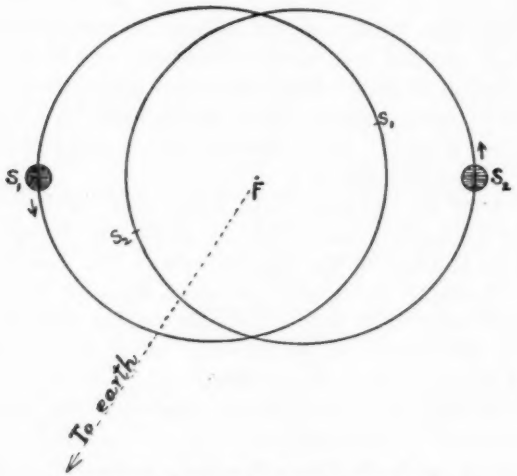


Diagram of the Stellar System Boss 6148

reduced, give us the radial velocities—the velocities in a line towards or away from us—at those times. It was found that there were two sets of stellar lines and that when one set was shifted in one direction, the other set was displaced in the opposite direction. The condition of affairs can be understood from an examination of the accompanying diagram. The star is in reality a double star, if we

were close enough to examine it, but, by reason of its great distance, the light from both stars is merged into one, and no telescope yet in existence is powerful enough to show it as a visual double star. Therein is shown the wonderful sensitiveness of the spectroscope. The calculation shows that the stars are nearly alike in mass and, being of similar type and brightness and, therefore, density, are quite similar in size. I have drawn the diagram as if they were perfectly alike, though the calculations show slight differences to exist. The diagram is drawn as if we were looking at the stars at right angles to the plane in which the stars revolve about each other; in reality, we should have our eye in the plane of the paper in the direction to earth, as indicated by the arrow.

The stars S_1 and S_2 mutually revolve about their common centre of gravity F in oval-shaped orbits, the mean diameter of each orbit being about 11,600,000 kilometres. (A kilometre is about ⅝ mile). At times the star S_1 will be approaching the earth as it revolves in its orbit and the star S_2 will necessarily be receding from the earth. At other times the conditions will be reversed and S_2 will be approaching, whilst S_1 will be receding. Remembering that S_1 and S_2 must always be at the opposite ends of a line through F and on their respective paths it is easy to trace their motions relative to the earth. One can see that when their direction of motion is at right angles to the earth there will be zero velocity measured and both sets of lines will be in their normal positions on the plates, being in fact super-imposed the one upon the other. Again when one star is receding at its maximum speed, the other will be approaching at its maximum speed and at such times the stellar lines will be thrown widest apart in the spectrum. By simple inspection of the velocities deduced, it is found that the cycle of operations is repeated every 12.155 days, which is the period of the spectroscopic binary, as this class of star is called. The orbits are not quite as circular (eccentricity is 0.28) as is usually the case for F-type stars.

As the stars are revolving about each other, another independent motion is revealed by the measured velocities. It is as if the two stars were performing their motions in the plane of the top of a desk, whilst the desk was being uniformly moved away in a straight line at about 12 kilometres per second. Thus the system that we know

as the one star Boss 6148 consists of two nearly similar stars whose masses are at least each 1.7 times that of our sun and whose combined light, if they were as close to us as the sun, would be nearly five times that of that body. They are revolving in oval-shaped paths about their common centre of gravity in a period a little over 12 days, with a velocity of about 45 miles per second, the mean distance separating them being of the order of fourteen and a half million miles. Furthermore, the system, as a whole, is receding from the earth at about seven and a half miles per second.

In regard to the distance of the stars from us, we are not left in the dark. Certain tell-tale marks in the star's spectrum give us the information as previously mentioned that the star gives out nearly five times the light of our sun. It is only a simple problem to calculate how far away, in comparison with the sun, the stellar system must be in order that it may shine as the faint star it appears to be. The calculation shows that the light which was recorded upon our plates in these recent years left the star itself about 100 years ago and has been winging its way to us at 186,000 miles per second since then.

Dominion Astrophysical Observatory,
Victoria, B.C.

PLATE XXII

Sunset on Mount Hamilton; Fog in the Valleys.

Journal of the Royal Astronomical Society of Canada, 1923.

THE DAWN OF NIGHT

(On Mt. Hamilton)

Now swings our mighty circle up the sky—
  The great equator climbing to the sun
  That shrills in voice of flame: "The day is done!"
Across yon darkening sea—vapours that lie
O'er Santa Clara's vale—our Pisgah eye
  Discerns the day's eclipse. No solemn gun
  Proclaims the obsequies, nor even one
Earth voice is heard to tell us night is nigh.

High in the zenith, o'er our bastion burns
  A timid star—'Tis Alpha of the Harp.
  Now gathering light, she sings out clear and sharp,
While every ear to her soft lyric turns:
  "Cease, child of earth, each helpless plight to nurse;
  And hear the music of the universe."

The white moon rising, floods the cloudy floor
  With fleecy billows, spreading wide and far
  A sea of silver with no coast to bar
Its shining verges. On the hither shore,
Great domes arise as from the earth's deep core
  To turn our sight where God's blue heavens are,
  To urge our souls, by vision of some star
Into the higher atmosphere to soar.

Beneath our mountain-wings, a sea of gloom
  Spreads o'er the earth its blight of war, its flood
  Of desolation, pestilence and blood,
But all above these clouds of dread and doom
  Is star-lumed peace that robes the vaster night
  In garniture of universal light.

ALBERT DURRANT WATSON.

THE AMATEUR ASTRONOMERS

By One of Them

THE amateur astronmer does not make any claim to distinction. He knows he is "just ordinary," and the best he ever hopes for is to get his bearings in the universe. The only difference between him and any other citizen is that he is a little more anxious than the average man to explore the unexplorable. He knows that he is crawling around on a spinning ball held in space without any visible means of support, but he tries to get and retain a sense of direction, just as the airman trains himself to preserve his equilibrium, no matter how far above the earth he may fly, or how strong an eddy he encounters. The amateur astronomer, unlike the rest of humanity, is not satisfied to utter the words of the hymn—

> Or if on joyful wing
> Cleaving the sky,
> Sun, moon, and stars forgot,
> Upwards I fly—

but rather he is hopeful that when his time comes to cleave the sky, he will at least have some knowledge of his surroundings. He would be unhappy if sun, moon and stars were forgot, and would want to remember those companions of Earth—the Planets, old Sol, and his most intimate friend, the Moon. The first thing he would want to do would be to take a look at that other side of the Moon which had ever been turned away from his earthly eyes.

No man really knows when he first became an astronomer, but the first symptom is when he begins to "see stars." That is, for the first time he notices that the stars are in clusters and groupings. A little later on, as the result of some reading, he finds himself making a more profound remark than that "the stars are out to-night."

It may be that about this time the moon—and the man in it—becomes to him something more than a yellowish globe, with dark

markings, and with the help of a spy-glass, he gets his first glimpse of that panorama of plain and mountain which is even more wonderful than the view from a mountain top of Earth. And yet so few avail themselves of this inexpensive trip to the Apennines of the Moon via the fascinating telescopic tube route. Flammarion says:

> Anyone who likes to be impressed by grand and magnificent sights may turn even a modest field-glass upon our luminous Satellite, at about first quarter, when the relief of its surface, illumined obliquely by the sun, is at its greatest value, and be astonished at its brilliancy and beauty, its outlines, its laces and embroideries—a jewel of shining silver, translucent, fluid, palpitating in the ether . . . . and to reflect that nine hundred and ninety-nine thousand nine hundred and ninety-nine millionths of the population of our planet should pass their lives without ever having attended to this pageant.

But to return to the amateur astronomer. Whether or not he is one man in a million, as Flammarion suggests, he may at least claim to have looked into infinity and been made sober by the experience. The study of the heavens is mental reconstruction, and leads away from mental aberration. Contemplation of the laws of the universe regulates the wheels of the mental machinery, and the cogs will in time adjust themselves to the eternal order of things. Perhaps this orderliness of mind and remoteness from the distraction of earthly things is what is known as being "in tune with the infinite." The "house by the side of the iron railings" was not built for the astronomer, but for those who have looked down, rather than up, and have become so engrossed with earthly affairs that when the break occurs, they imagine themselves earthly potentates, such as kings and queens, popes and presidents. Who ever heard of an "inmate" claiming to be Orion or the planet Jupiter?

However, it is hardly necessary to warn an astronomer against taking a path that leads to the Foolish House. The very nature of his hobby turns him in the direction of rational thought. Astronomers have been particularly sane, scientific men, and they have also been very human and understandable, with a readiness to laugh at themselves or the strange freaks of creation. Even Barnard would amuse himself and others at the expense of the universe, and would

turn a lantern slide of a nebula upside down, if it looked more grotesque that way; enjoying the fun as much as his audience.

Astronomy really should be popular because the amateur astronomer, or the professional, is not likely to give anyone the impression that astronomy is a spooky, mysterious or high-brow cult. While the subject is as big as the universe, the very bigness in comparison with the human mind makes it seem companionable; just as a child might play with an elephant and feel that no loss of dignity has been sustained on either side.

But the amateur astronomer has reason for the self-abasement and the feeling of being just a very ordinary being, referred to at the opening of these remarks. The very scientific nature of his hobby appals him; the ponderous facts of the universe weigh him down, and while he frequently makes a discovery, it is always something already known to the "professionals." However, his "discovery" may be genuine enough so far as he is concerned, and he is in no worse position than the present-day author who finds that no matter how great a thought he uncovers, it is extremely likely that one William Shakespeare had it also, and expressed it better than he can. Nevertheless, Copernicus was an amateur astronomer, at first, and his early distinction arose because there were so "few of him"—and that may have been brought about because of the personal danger attached to membership in that limited organization. There would be a lesser number of amateur astronomers in this country if the facts of astronomy had to be maintained, as of old, in defiance of persecution. As it is, an amateur can "discover" a new star at any time, even though it may only prove to be Venus in an early morning sky; the only result being to make Venus as mad as the horned Moon when an uninformed poet inserts "one bright star within her nether tip."

Nevertheless, we owe much to the amateur astronomers, such as Copernicus *was*. The Copernicuses of the present day are the amateur astronomers, and any one of them will sit up all night if somebody will only guarantee that he will make a discovery—but nobody wants to be poking around in the early morning in a bathrobe looking at the stars, unless he is sure of a discovery of some kind. Men have been known to make a special trip to the Antipodes

(a group of islands mid-way between Norway and Sweden!) just to get a photograph of the sun when it is out of sight; but that is not for the amateur, who likes to make his discoveries nearer home. These men of the professional class, it will be noticed, always make their discoveries from some remote part of the world, or from the labyrinth of their laboratories, and it would be interesting to speculate whether matters are not still in the same condition as in the olden days, when the amateur astronomers were suppressed by the men in control of the thought of the world; that is, by the astrologers and priests, who in our day are known as scientists and professors. Here is a sample of the kind of revolutionary thought which seldom gets a chance for expression, but which proceeds from the active brain of the amateur astronomer:

> A perusal of page 56 of the "Observers' Hand Book" shows clearly that not only does the moon still await a discoverer, but that it has no stellar magnitude. That great name, and the minute calculation required to establish the stellar magnitude of our satellite, will be given out shortly, but what chance is there of having the whole truth accepted—that as a matter of fact the earth has two satellites; one just behind the other. Double stars are a common phenomenon, so why not a double satellite? Our two satellites are so close together that the smaller one is never seen, being in permanent eclipse. When travelling in their common orbit around the earth, they often scrape against each other—which accounts for the phenomenon known as the audibility of the Aurora, which has exercised so many minds and ears. The sound can often be heard when listening in on the radio, and when this is more generally known, there will be less unscientific language used by people who blame it upon the static conditions.

This paper would not be complete—and everyone will want to have a paper like this complete—without a referencce to the Einstein Theory. If there is one thing the amateur astronomer does understand, it is the Theory of Relativity. He has difficulty in making people understand what it is he does understand, but Einstein himself had some trouble along this line. The amateur astronomer can readily visualize a four-dimensional figure, given the proper combination of circumstances, and Time as the fourth dimension has absolutely or relatively no terrors for him. The only difficulty he

has with time is to keep pace with the heavenly bodies, the most interesting phenomena always seeming to occur at a time of night or early morning when—well, as only poetry can express it—

> When the crescent Moon sets in the Eastern sky,
> And the Pleiades sing in the trees overhead,
> While Sirius glows like a big red eye,
> That's the time you will always find him in bed.

REVIEW OF PUBLICATIONS

OBSERVATIONS ON THE DEFLECTION OF LIGHT IN PASSING THROUGH THE SUN'S GRAVITATIONAL FIELD.

Lick Observatory Bulletin, Number 346, contains part of the results of the Wm. H. Crocker Eclipse Expedition from the Lick Observatory to Wallal, Western Australia, for the purpose of testing the deflection of light rays on passing through the gravitational field of the sun. The paper covers only a part of the evidence obtained by the expedition on the subject, but the results are decisive and are presented in a clear and convincing manner.

The instrumental equipment consisted of four cameras carried by two separate equatorial mountings. Two of the cameras were fitted with lenses of 15-feet focal length and were mounted side by side as a twin camera. The other mounting carried two lenses of 5-feet focal length mounted similarly. The results in the paper refer to the four plates taken with the long camera. The plate holders accommodated plates seventeen inches square and as the definition of the lens was good, even at the edge of the plates, the usable field was about 5 degrees square.

The general method of attack was to photograph the region around the sun during the interval of totality and to compare the positions of the star images on these plates with those on plates taken under similar conditions of the same region when the sun was absent. These latter plates, which are referred to as check plates, were taken several months previously by Mr. Trumpler on the island of Tahiti at a time when the telescope was at the same zenith distance and hour angle as it would occupy at the time of the eclipse.

It might be urged that in taking the comparison or check plates at one station and the eclipse plates at another, there might be a chance for some instrumental change to take place, which would introduce an artificial distortion of the fields. To have a check on

this, both the Tahiti plates and those taken at Wallal were exposed to a region of the sky approximately six hours East of the Eclipse field. At Tahiti, the Eclipse field was photographed around ten o'clock in the evening, and the plate holder left undisturbed in the telescope and exposed about four-thirty in the morning to the check field six hours East. At Wallal, the check field was exposed the night before and the night after the eclipse. As two plates only were exposed in each camera, it was possible in this way to put the check field and the eclipse field on each plate without disturbing the camera or plate holder in any way, save the once replacing and withdrawal of the plate holder slide. Plates of the check region thus served to eliminate some of the instrumental changes and to establish the fact that there were no instrumental errors which had not been eliminated.

From 62 to 85 star images were measured on the eclipse field. While a great many star images appeared in the check region six hours East of the sun, only 37 of the best images, well distributed over the plate and of suitable brightness, were selected. All of the plates were measured by Mr. Trumpler, and three out of the four by Mr. Campbell. When the plate constants had been determined, the radial component displacements of each star were calculated and the weighted means formed. The results are more readily appreciated if the stars are divided into groups at various distances from the sun. They give the grouping as shown in the table below.

GROUP MEANS OF OBSERVED RELATIVE RADIAL DISPLACEMENTS.

Group	Stars	Mean Dist. from Sun	Observed Rad. Displacement	Theory
1	8	0°.64	+0″.64	+70
2	11	1 .06	+0 .35	+37
3	10	1 .40	+0 .30	+24
4	8	1 .66	+0 .16	+17
5	9	1 .90	+0 .17	+13
6	8	2 .00	+0 .15	+11
7	11	2 .22	+0 .08	+08
8	13	2 .55	—0 .09	+02
9	14	2 .97	—0 .04	—03

The displacements shown in this table are relative to the outer stars on the plate. In order to determine what Einstein shift at the limb of the sun they are in best agreement with, they were fitted into the formula

$$\Delta r = ad + \beta \frac{R}{d}$$

where

Δr is the observed relative displacement
a is a change in scale value
R the radius of the sun's disk
β the light deflection at the limb

A solution was made for each of the four plates, keeping Mr. Campbell's and Mr. Trumpler's measures separate. The results are very accordant.

Plate	Campbell	Stars	Trumpler	Stars
1	1.72 ±.32	62	1.88 ±.27	69
2	1.35 ±.22	77	1.62 ±.22	81
3	1.78 ±.22	80	1.91 ±.19	84
4			1.76 ±.22	85

Mean of four plates 1.72 ±.11
Einstein's predicted value 1.745

It can thus be seen that Einstein's predicted value is verified in a most striking manner.

When the stars for the check regions were grouped according to the distance from centre of plate and the radial component of displacement computed as for the eclipse regions, the table given below was obtained:

		Campbell		Trumpler	
		Dist. from	Radial	Dist. from	Radial
Group	Stars	Centre	Residual	Centre	Residual
1	7	0.76	—.16	0.76	—.05
2	6	1.24	—.15	1.24	—.09
3	6	1.79	—.10	1.79	—.02
4	6	2.17	—.01	2.17	+.01
5	6	2.72	+.16	2.71	+.04
6	6	3.08	+.02	3.12	+.01

As the writers of the Bulletin remark, the large star displacements near the sun found in the eclipse field have no counterpart in the check field and can, therefore, not have their source in any instrumental errors, nor can they be due to the peculiar method of measuring and reducing the plates. They note, however, that there are some small systematic deviations in the check stars. After examining the nature of these differences, the authors suggest the existence of an effect additional to that of Einstein's theory. This effect is small at the sun's limb and rises to a maximum of about 0″ 4 at 2° to 3° from the sun's centre. However, this point is not stressed, as better material for its investigation will be found on their plates taken with the five-foot camera and they postpone further discussion until the plates taken with that instrument have been measured.

R. K. Y.

Eclipses of the Sun, by S. A. Mitchell, Professor of Astronomy in the University of Virginia and director of the Leander McCormick Observatory. New York: Columbia University Press, 1913. XVIII. + 425 pages, 6 × 8¾ inches. Price $3.85.

It is not many months since Dr. Mitchell published a large volume containing the parallaxes of 260 stars, obtained with the aid of the 26inch telescope of the Leander McCormick Observatory by himself and a small number of assistants. To anyone who has read the history of the determination of the distances of the stars, this work appeared sufficient to have completely absorbed Dr. Mitchell's nights and days for the last decade.

Now comes this large and handsome volume on Eclipses of the Sun. It is a mine of information, not only regarding eclipse phenomena, but also concerning practically every important astrophysical investigation made upon the nature and condition of the sun. The whole is illuminated by numerous historical references which show a very wide range of reading by the author and which will make the book more interesting to the general reader.

There are twenty-one chapters, dealing with the following subjects: Early historical eclipses, biblical and classical eclipses, the prediction of eclipses, the verification of eclipses, the spectroscope, the

surface of the sun, modern eclipses before 1878, nineteenth century eclipse after 1878, personal experiences in 1900 and 1901, the Spanish eclipse of 1905, the American eclipse of 1918, the flash spectrum, heights of vapour in the solar atmosphere, eclipse spectra and related solar problems, the structure of the atom, the importance of ionization, the corona, coronal theories, the Einstein theory of relativity, has the Einstein theory been completely verified?

The book begins with a discussion of the famous Chinese eclipse of 2137 B.C., on which occasion the royal astronomers Hsi and Ho got drunk, failed to do their duty and in consequence lost their heads. The account of this eclipse is given in the ancient classic *Shu Ching*. As a sample of the general information given by the author, the following paragraph may be quoted:—

> The *Shu Ching*, or Book of Historical Documents, is a collection of public speeches and proclamations beginning with the reign of the legendary Emperor Yao, who lived in the twenty-fourth century, B.C., and closing with the year B.C. 625. The book is not a historical chronological narrative, nor indeed does such a book exist in the Chinese language. This ancient eclipse has been fully discussed by a number of eminent authorities. The most complete monograph is by Schlegel and Kuhnert, Die Shu-King-Finsterniss, *Verhand, der Konin. Akad. van Wettenschappen Letterkunde* 19, 5, 1890. Oppolzer communicated to *Monatsberichte der Kon. Preuss. Akad. der Wissens. zu Berlin*, 166, 1880. Briefer accounts may be found by S. M. Russell, *Observatory*, 18, 323 1895; in Chambers' *The Story of Eclipses*, 65, 1900; and in the Halley Lecture, delivered by Dr. J. K. Fotheringham, May 17, 1921.

In the first chapter is also an account of Eclipses of Babylon and of Egyptian Astronomy. A description of the excavations at Nineveh and at other places, together with the deciphering of the cuneiform inscriptions, is given, and then follows a concise sketch of the study of science in Egypt. "In spite of many writings to the contrary, it appears tolerably certain that the Egyptians, throughout the long years of their interesting history, contributed but little to the *science* of astronomy."

Two chapters (36 pages) are devoted to the spectroscope. They give a very readable history of the development of spectrum analysis, including an account of the ruling of diffraction gratings. The author's personal experiences in 1900, 1901, 1905 and 1918 are

described in three chapters, and many interesting notes on the people met and the places seen are given.

After this is an explanation and discussion of the flash and other eclipse spectra. Dr. Mitchell obtained some excellent photographs of the flash spectrum.

Then follow well-written and comprehensive chapters dealing with the nature of the atom, Saha's theory of ionization, and the structure and nature of the corona.

Chapter XX. gives an outline of Einstein's theory of relativity, while the following and concluding chapter describes efforts made to test the Einstein theory. These efforts include those of the English parties in 1919 and of the United States and Canadian parties in Australia in 1922.

The work is illustrated by 59 plates, three of them being coloured, and amongst them are some of the most remarkable photographs taken of the corona, the prominences, the spectra, and the face of the sun. The explanations are in clear and simple language, the style is popular and readable, and the book will be found of absorbing interest to scientist and layman. The present writer would place it alongside the well-known works of Agnes M. Clerke.

C. A. C.

MEETINGS OF THE SOCIETY

AT TORONTO.

October 2nd, 1923.—The first meeting for the autumn term was held in the Physics Building of the University at 8 p.m., the President, Mr. W. E. W. Jackson, in the chair.

The programme of this meeting consisted of reports of observations and notes by members made during the past summer. Prof. Chant reported that the expeditions which went out to see the total eclipse of the sun on Sept. 10, into Southern California and Mexico, had mostly failed to get any observations owing to the cloudiness of the weather. He also referred to a recent book on eclipses of the sun by Prof. Mitchell, of the Leander McCormick Observatory, and described some of its contents. Prof. Chas. E. St. John, of Mount Wilson, has recently announced that the lines of the solar spectrum have a displacement towards the red end, thus verifying the predicton of Einstein, in the application of his general theory of relativity. Prof. Chant referred to the remarkable fireball which he observed in the evening of Sept. 1, from Go-Home Bay, and which he described in the JOURNAL for September. This next total eclipse of the sun, which will take place on January 24, 1925, and will be visible in its totality at Toronto, was then dealt with briefly.

The President, Mr. W. E. W. Jackson, gave an account of some observations on the magnetic state of the earth, made during the recent total solar eclipse on September 10, and some of the results obtained showing a distinct diminution in the earth's field during the passage of the moon's shadow across the earth. It tends to show how much of the earth's magnetic field is under the control of the sun. In the total eclipse of June 8th, 1918, there was a definite effect first observed in the magnetic state of the earth. Mr. Jackson stated that sunspots have not been very numerous during the summer months. He gave a list of those groups which had been observed, and their dates.

Mr. A. F. Miller had observed the limb of the sun on many days in the summer. On the day of the total eclipse (September 10) there was only one small prominence visible. Mr. Miller also desribed some results he had obtained in spectroscopic work, and read an account he had written for the JOURNAL on the reviving of a "dead" helium tube by exciting another near it. He ascribed this effect to resonance.

AT VICTORIA.

March 27, 1923.—A regular meeting of the Society was held in the Auditorium of the Girls' Central School at 8 p.m. The President, Mr. W. E. Harper, in the chair.

Mr. E. E. Blackwood was proposed for membership.—Carried.

In view of the number of subjects to be presented to the meeting it was thought desirable to postpone answering the queries from the "Question Box."

Due to an indisposition, Mr. A. Coddington was not present to give his address on "The Evolution of Worlds."

Upon the call of the chair, the following subjects were presented:—

(1) Mr. F. Moore spoke on "The Causes of the Seasons." By means of a model, it was shown how the seasons depend on the diurnal rotations of the earth about its axis, its annual motion round the sun and the obliquity of the ecliptic. Reference was also made to the effect of greater eccentricity of the earth's orbit in modifying the seasons.

(2) Mr. P. W. Maunsell next gave his address on "Light." A very clear explanation was given how the astronomer Roemer obtained the velocity of light through the discrepancy between the observed and predicted time of eclipses of Jupiter's satellites when the planet was near opposition, and when near superior conjunction. The lecturer then described modern methods by means of a toothed wheel and also a rotating mirror.

The time limit imposed prevented a full presentation of the pressure effect of light, which was stated to be about 70,000 tons of the earth's surface.

(3) Mr. P. S. Langdon addressed the meeting as to how a person gains or loses a day when travelling round the world and attention was drawn to the international date line that had been established on the 180th meridian to avoid confusion.

(4) Mr. J. C. Watters gave a very detailed and interesting account of how he had ground and polished an 8-inch reflector, which was exhibited to the meeting. The various "snags" likely to be experienced by an amateur were given. Foucault's knife test was described. Mr. Watters' experience should encourage other members of the Society to make a like attempt.

(5) The Rev. W. Lashley Hall gave his impressions of Mount Wilson Observatory. What had appeared to the eye to be dark spots on examination by the telescope, turned out to be a perfect stream of stars. Slides were shown, the cluster in Hercules being particularly fine. The speaker, in closing, dwelt on the wonderful endowment given to the human mind, which made it possible to construct instruments reaching out to the depths of space and appreciate the marvels thereby revealed.

Mr. F. N. Denison moved that the Secretary be instructed to forward a letter to Dr. J. S. Plaskett, F.R.S., congratulating him on being elected a member of the Royal Society. It was carried unanimously.

F. MOORE, *Secretary.*

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries

A Great Telescope for the Southern Hemisphere

The Yale University Observatory has entered upon a great project for the southern hemisphere. It has ordered from J. B. McDowell (successor to Brashear) of Pittsburgh, the optical parts of a 26-inch photographic telescope of focal length 36 feet, consisting of the 26-inch objective, a 10-inch objective of the same focal length for a guiding telescope, and an 8-inch correcting lens, to adapt the telescope for visual observations. The telescope is to be completed in one year.

The instrument is to be erected either in New Zealand or South Africa, and our astronomical friends in the former dominion are making an effort to secure it. I presume the instrument will be used chiefly for the determination of stellar parallaxes, a field in which Dr. Schlesinger, the director of the Yale Observatory, has achieved distinction. New Zealand has been asked to supply a site and erect the buildings the total cost being about $50,000. The Observatory will pay the salaries of two qualified astronomers for at least ten years. The cost of the telescope is put at $45,000.

The matter is not yet finally settled, but indications are that the New Zealand government will accept the proposal. A probable site, it is reported, is near Dunedin in latitude 45° south.

Meteors in September

In the last number of the Journal a report was made of a very brilliant meteor observed at about 8 p.m. in the south-west direction from Go-Home Bay. The present writer judged from its brightness that it was not more than 60 miles away, possibly in the neighborhood of Collingwood.

Mr. T. H. Wingham informs me that people in Hamilton and Barrie saw the meteor, that it was red in colour and very brilliant, was travelling toward the south-east and going very fast. Other observers in London and near Detroit also observed it, but sufficiently accurate information was not received to determine its

position accurately. It would seem however that it was much farther off than at first supposed.

The newspapers of September 18 contain an account of an immense meteor seen on September 16 by the second officer of the S.S. Orbita at early dawn (5.50 a.m. Greenwich time) in latitude 46.12 north and longitude 38.43 west. It crossed the heavens from southwest to northeast, and left behind it a luminous greenish trail which suffused the heavens for 20 minutes.

Four days later a meteor was reported to have fallen at Madison, N.J., at about 5 a.m. on September 21. The phenomenon was not actually seen by anyone, but a hole five feet deep and three feet wide was torn in the pavement! There was a great flash of light and the houses were shaken. No further news has been received.

The Total Solar Eclipse of September 10

A large number of extensive and well-equipped expeditions from various parts of the United States were located in southern California and the near-by portion of Mexico, but clouds effectively prevented observations of any value.

Farther east in the interior of Mexico conditions were more favorable, and at Yerbaniz, in Durango, the Sproul Observatory expedition was successful in accomplishing about nine-tenths of its programme. An expedition from the National Observatory at Tacubaya was also located here and made successful observations. It was at this place that the present writer had hoped to be, and he is delighted that others there met with good conditions. The corona is reported to have been of the typical minimum sun spot type.

C. A. C.

The Royal Astronomical Society of Canada

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THE FESTIVAL OF THE DEAD, by R. G. HALIBURTON.

This very scarce pamphlet, printed privately in 1863, was republished in the JOURNAL of the R.A.S.C. and can be obtained in a book of 126 pages. The work discusses the Year of the Pleiades and various questions relating to old calendars. It is of special interest to astronomers, anthropologists and ethnologists. Price $1.00, post-paid.

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BULLETIN DE LA SOCIÉTÉ ASTRONOMIQUE DE FRANCE. Volume 5, for year 1891.

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